



Research article

A cross-sectional study to determine factors affecting dental and medical students' preference for virtual learning during the COVID-19 outbreak

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ABSTRACT

Virtual "online" teaching has been adopted by most universities around the world during the COVID-19 outbreak. This study aims to investigate the factors that might affect students' preference for virtual learning. Since a second wave of such pandemic is expected to occur, professors and teaching assistants may want to be prepared and aware to create an effective virtual learning environment for students.

Using an online survey questionnaire, a total of 488 students in their basic science years of study (first to the third year) who are enrolled in dental and medical college responded to the online survey. The authors utilized a binary logistic regression model to estimate the impact of the nine explanatory variables (gender, student's year of study, accessibility of online tools, class engagement in virtual classes, GPA change during COVID-19 outbreak, class attendance in virtual vs. in-person lectures, type of study material, time saving for virtual classes, and anxiety level during the COVID-19 outbreak) on the students' preference for virtual learning. The analysis of variance showed that three out of the nine variables were not significant to the model: gender, study level, and study material. In addition, to understand the behavioral intention for the students during such pandemic, the online survey questionnaire captured students' voice on their willingness to wear masks, wash their hands, or both as well as their acceptance to take the vaccine once it is available. The results showed that 7.02 % of the students did not change simple health behaviors and 18.43% are not interested in taking the vaccine. This implies the importance of enacting new laws for reopening universities, applying high fines for violators, and obligating students to take the vaccine since university settings have high levels of social contact with populations from different communities and countries.

1. Introduction

Although older people are among those at a higher risk for severe illness from coronavirus disease 19 (COVID-19), young adults can be infected and can transmit the virus to others [1, 2]. In fact, during a pandemic, young adults are more likely to be disease-ridden and asymptomatic, which increases the possibility of university campuses becoming hot spots for disease spreading [3]. A previous study explored the perception of invincibility in young adults with many young adults believing that they will not be affected by disease; this is particularly worrying in the case of COVID-19 as asymptomatic virus carriers can become the catalyst for community spread [4]. Taking precautionary action is essential to minimize the spread of the diseases at institutions and surrounding communities [3].

The global COVID-19 pandemic emanating from Wuhan, China has ravaged the world. As of September 2020, more than 28 million cases of COVID-19 and over 900,000 deaths have been recorded worldwide. COVID-19 is caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) and presents variably from asymptomatic infection to as a severe pneumonia-induced death [5]. SARS-CoV-2 is highly contagious, which enforces the need for social and physical distancing measures to slowdown the spread of the disease [6]. Moreover, it is imperative to examine the effects of COVID-19 on higher education in general and on dental and medical students-future healthcare practitioners in particular. On March 2nd, 2020, the Ministry of Health confirmed the first case of COVID-19 in Jordan. Even though the country only had one confirmed case, on March 14th, the government mandated social restrictions including suspending school, banning large gatherings and restricting

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local and international travel to ensure the safety of the nation against the ensuing pandemic. Around the world, university campuses were closed mid-to late March 2020, and face to face/in-person instruction was disrupted. Because of the rapid nature of disease onset and spread, many institutions were caught off-guard and were unprepared for the switch to online learning [7]. In many cases plans for virtual learning were cobbled together overnight. The hasty transition, a general lack of preparedness, and bandwidth led to an unfulfilling virtual learning experience for both instructors and students [8, 9].

While it is difficult to differentiate the efficacy of instruction delivery formats on a whole scale across disciplines and institutions, general perception regards virtual learning as being of lesser quality compared to face-to-face instruction. However, emerging work shows that there is no significant difference among delivery formats including face-to-face, blended, and virtual instruction [10, 11, 12]. For example, a study among medical students from Saudi Arabia revealed that the online teaching is a well-received modality that has many advantages including time saving and a better students' performance [13]. However, the rapid transition of many institutions towards virtual teaching masks the perception of virtual learning as a low quality choice, though, under these circumstances the transition did not take full advantage of the affordances and possibilities of the online format [11]. With increasing demand for virtual teaching, instructors need to acquire new skills and adapt to the increasing number of students' inquiries [14]. A study among Dental Medicine students at Harvard School revealed that the move to e-learning has worsened their learning with increased stress, decreased engagement, and the same perception level of class attendance. Students reported a preference for recorded live lectures and prerecorded lectures with live follow-up sessions as a mode of teaching in comparison to nonrecorded live lectures [15]. Effective virtual teaching seeks to prepare a well-designed learning environment that engages the student with their faculty and peers as well as with the class content [16].

The recent advances in computer and internet technologies have helped in the development and improvement of distance/virtual learning [17, 18]. Virtual learning has several potential benefits which include the low cost, effectiveness [19], accessibility, and a learning opportunity that generates well prepared students for a knowledge-driven society [20]. In addition, virtual learning is a flexible approach that allows students to access their courses at different times and locations [21]. Crucially, virtual learning allows for enhanced individualized learning. Students can take advantage of autonomous learning software, such as adaptive learning, where the teaching will be customized for each student's need depending on the different interactions between the students and the lesson or the students and the teacher [22, 23]. On the contrary, a study by Xu et. al. showed that online teaching can have negative impact on both student persistence to the end of the course and on the final grade for persistent students. Low achieving students, and students requiring additional support may struggle and feel isolated in an online environment. This suggests that institutions have a role to play by improving their teaching, making virtual learning accessible to all students, and ensuring that student learning outcomes are comparable in quality and standard in both virtual and face-to-face platforms [24].

Many factors influence students' preference towards virtual learning. A study was conducted in 2011 by Leping Liu at the College of Education in the University of Nevada, Reno and explored the influence of seven factors on virtual teaching preference. Of the surveyed factors, only five factors were found to significantly influence students' preference. Those being gender, technology skills, previous online courses, working status, and learning pace. Factors that did not influence preference were major or discipline of study and communication style that was used in instruction [25]. Aside from these factors, student training, instructor training, and consistent scheduling pattern are key players that influence the success of virtual teaching [26]. Importantly, Joshi et. al. (2020) conducted a study that highlighted the influence of work-life balance, lack of social interactions, and academic integrity on virtual teaching. Compared to face-to-face instruction,

students lamented the loss of collegial atmosphere. Indeed, peer to peer teaching and collaborative work is vital to the development of well-rounded students [27].

We conducted this survey to assess factors that might affect students' preference for virtual learning during this disease outbreak including gender, student's year of study, accessibility of online tools, student engagement in virtual classes, GPA change during COVID-19 outbreak, class attendance in virtual vs. in-person lectures, type of study material, time saving for virtual classes, and anxiety level during COVID-19 outbreak. Further, our study aims to better understand the perceptions and behaviors of students during a general global pandemic. This informational is critical for administrators and decision makers at higher education institutions to gather input from students' experiences on the effect of the COVID-19 pandemic on student learning and prepare students for a possible second wave later in 2020. Significantly, administrators, parents, and students all need to be well informed and clear in this regard as they prepare for either campus reopening or an extended hiatus from campus.

2. Research questions

This study aims to examine the following research questions:

1. Is it feasible to predict the dental and medical students' preference for virtual learning of basic science courses (first to the third year) through the following main variables:
 - a) Gender b) student's year of study (first, second, or third year) c) accessibility of online tools d) class engagement e) GPA change during COVID-19 outbreak f) type of study material (e.g., book, recorded videos, PowerPoint) g) class attendance h) time saving i) anxiety level during COVID-19 outbreak
2. What are the significant variables (which are listed in the question 1) that influence students' preference for virtual learning?
3. How prepared are students in the event of a second wave?

3. Methodology

3.1. Experiment design (calculate minimum sample size for the survey)

The minimum number of sample size which is required for this study was determined based on three factors:

- 1) students' population size
- 2) margin of error which was set to be $\pm 5\%$ which is an acceptable value for categorical variables [28].
- 3) confidence level that was set to be 95% for this design experiment [28, 29, 30].

The total number of dental and medical students in their first to third year of study who were enrolled in the spring of 2019/2020 academic year is as in Table 1.

Based on the above information and using the following equation, the minimum number of sample size is 347 surveys [29, 31, 32].

$$S = N * \frac{X}{X - 1 + N}$$

Table 1. Number of enrolled students per each level of their study.

Student Year of Study	Number of Students
First Year	1720
Second Year	911
Third Year	981
Total	3612

where S is the sample size, N is the population, and

$$X = Z^2 * p * \frac{1 - p}{MOE^2}$$

where Z is the critical value of normal distribution (1.96 is the value for 95% confidence, p is the sample proportion (0.5), and MOE is the margin of error.

3.2. Missing values in the survey data

In general, missing data in the surveys is the result of several factors. For example, some of the participants may skip answering some questions intentionally due to privacy issues, stress, or lack of knowledge. Other reasons might be that insufficient time that was given to the respondent to complete the questionnaire or the survey was too long which requires a greater amount of time to be completed which drives the respondent to lose interest [33, 34, 35]. However, our survey consisted of only twelve multiple choice questions. Every question in the survey without an answer is considered as a missing data point.

Missing data can be deceiving since it is hard to identify the problem. Besides, it is not always understandable when missing data can be a serious problem. For instance, each variable or question in the survey may only have a small number of missing responses, but grouping all of these missing responses in the survey could result in numerous total missing points [36, 37]. Therefore, it is essential to assess the missing points to successfully manage the survey data and avoid any type of inaccurate interpretation regarding the data.

3.3. Handling missing values

Missing data is considered as a rule rather than an exception in quantitative studies [38]. A missing proportion of 15%–20% is usually common in psychological and educational research. Experts have not determined a cutoff point for the percentage of missing data that turn out to be problematic. Schafer recommended a cutoff point of 5% [39]. Bennet suggested that if 10% of data is missing, statistical analyses are more likely to be misleading [40], however other studies have used data that has 20% missing points [41]. Of note, the nonresponse rate in our

survey is 1% of the total sample (n = 5), therefore the amount of bias will be very small. Hence, dropping or omitting those records from the analysis is a reasonable approach [42].

3.4. Survey design and implementation

A panel of four experts in educational technology and science or medical fields evaluated the items in the survey to assess the content validity. The questionnaire was piloted with 25 students and feedback responses were collected regarding the clarity and validity of questions.

The final version of the questionnaire was composed of twelve multiple choice questions. The questionnaire was created using Google forms and the link for this form was distributed among medical and dental students in their basic years of study (the first to third years) at Jordan University of Science and Technology (JUST). No personal or identifying information was sought. The survey was anonymous, neither e-mail nor IP addresses were recorded for any respondent and responses were saved in PT's Google account. Ethics approval was granted by the Institutional Review Board (IRB# 13/134/2020) at University of Science and Technology. The questionnaire captured students' voice on the following variables which are shown in Table 2.

The questionnaire was available from June 20, 2020 to July 25, 2020. The collected information was recoded as illustrated in Table 2 and then entered into a database.

4. Statistical analysis

Statistical packages Minitab version 17.0 was used to analyze the survey data. High levels of descriptive analyses were used in describing the characteristics of the survey participants.

A binary logistic regression model was utilized to identify the major variables that influence students' preference for virtual learning, and then develop a logit model to analyze the relationship between the explanatory variables and the response variable [43]. The logit model has previously been applied by Jimenez and Salas-Velasco to model educational choices. Logistic regression is a model that predicts categorical variables. Logistic regression can fit data with both binary and multi-class targets. Logistic regression, also referred to as the logistic model or logit model, analyzes the relationship between multiple independent variables

Table 2. Variable recoding.

Variables	Values				
	1	2	3	4	5
Gender	Female	Male	-	-	-
Student's Year of Study	First Year	Second Year	Third Year	-	-
Accessibility of online tools	Depending on the situations	Easy	Hard	-	-
Class Engagement in the virtual classes	No	Yes	-	-	-
Preferred learning method	In-Person	Virtual	-	-	-
GPA Change during COVID-19 outbreak	Decreased	No Change	Increased	-	-
Class attendance in virtual vs. in-person lectures	Student attends more lecture for in-person courses	Student attends more lecture for virtual courses	Same	-	-
Type of study material	A written audio content	Power point slides	Reading from the reference book	Summarized handout by the instructor	Watching the video record of the lecture
Time saving for virtual classes	No	Yes	-	-	-
Anxiety level during COVID-19 outbreak	Anxious	Disinterested/not anxious	Neither	-	-
Students' health behavior adaptation	Did not change simple health behavior	Hand washing	Mask wearing	Both (hand washing and mask wearing)	-
Students' acceptance to take vaccine once it is available	Interested	Not interested	-	-	-

and a categorical dependent variable and estimates the probability of occurrence of an event by fitting data to a logistic curve [44].

Logistic regression is a flexible approach and independent of the relationship between input and target variables. The main benefit of using logistic regression is its capability of determining the proportional or inversely proportional relationship between the input and target variable. There are two types of logistic regression: the *binary*, where the target variable is binary, and *multi-class*, where the target variable has more than two categories.

In this study, a binary logistic regression model was used to describe the relationship between a binary response categorical variable (Preferred learning method) and a set of explanatory variables (Gender, Student's Year of Study, Accessibility online tools, Class Engagement in the virtual classes, GPA Change during the COVID-19 outbreak, Class attendance in virtual vs. in-person lectures, Type of study material, Time saving for virtual classes, Anxiety level during the COVID-19 outbreak). In addition, a descriptive analysis for students' behavioral adaptation and their willingness to take the vaccine when it is available was performed. A schematic diagram for developing a binary logistic model for this study is shown in Figure 1.

5. Results

5.1. Demographic statistics

A total of 488 students agreed to participate in the study. Most of the participants were female students (57.58%). Almost two-thirds of the respondents (64.33%) were first-year students, and the other third were second- and third-year students. The detailed characteristics of participants are shown in Table 3.

5.2. Significant variables that predict dental and medical students' preference for virtual learning

First, students' voices regarding their preference for virtual versus in person learning was assessed. Most of the students (67%) preferred in person over virtual learning. However, only 32% of students preferred virtual learning in comparison to in campus (data is not shown).

Then, to determine the variables that significantly influence the students' preference for virtual learning, a binary logistic regression analysis was carried out to examine all the defined explanatory variables Table 4. The analysis of variance showed that three out of the nine variables were not significant to the model as shown in the table below: Gender (Wald

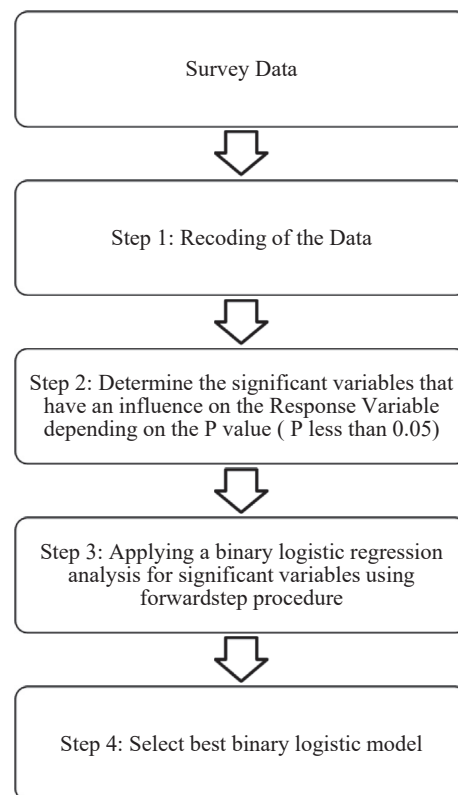


Figure 1. Steps for developing a binary logistic model.

Receiver Operator Characteristic (ROC) curve was plotted. The ROC curve diagnoses if the model can be used as good classifier. The area under the curve is 0.8304 (Figure 2), which indicates that the model can be used to predict students' preference for virtual learning.

The estimate of the regression coefficients (Coef (Table 5) was used to formulate the logistic regression equation [1]. The standard error of the coefficient indicates the precision of the estimate of the coefficient. The smaller the value, the more accurate estimate. In addition, the coefficient p-values are calculated based on the Wald tests. Both the class engagement and class attendance have the smallest p-values ($p < 0.00001$), which indicate that both are the closest significant predictors for students' preference for virtual learning.

$$\begin{aligned}
 \text{logit}(\hat{p}) = & 3.568 + 0.598 \text{ Accessibility of online tools_2} - 1.928 \text{ Ease of accessibility of} \\
 & \text{online tools_3} + 1.401 \text{ Class Engagement in the virtual classes_2} \\
 & + 0.559 \text{ GPA Changing during COVID - 19 outbreak_2} + 1.079 \text{ GPA Changeduring COVID - 19 outbreak_3} \\
 & + 2.069 \text{ Class attendance in the virtual vs. in - person lectures_2} + 0.828 \text{ Class attendance in virtual vs. in - person lectures_3} \\
 & + 0.846 \text{ Anxiety level during COVID - 19 outbreak_2} - 0.011 \text{ Anxiety levelduring COVID - 19 outbreak_3} \\
 & + 0.793 \text{ Time saving for virtual classes_2}
 \end{aligned}$$

Equation 1

$x^2 = 0$, $p > 0.05$), Study level (Wald $x^2 = 1.61$, $p > 0.05$), Study material (Wald $x^2 = 2.07$, $p > 0.05$). Therefore, these three variables were eliminated and not included in the next model examination.

The logistic regression analyses showed that the model was highly significant with the six significant variables ($x^2 = 116.54$, $p < 0.001$). The Hosmer and Lemeshow Goodness-of-Fit Statistic was not significant ($x^2 = 5.48$, $p > 0.05$), indicating that there is not enough evidence to conclude that the model does not provide a good fit for the data. The

5.3. Significant variables influence on students' preference for virtual learning

A coefficient value indicates the extent to which a particular explanatory variable contributes to the possibility of the response variable to be virtual learning. For example, when the student attends more online classes than in person classes (Class attendance in virtual vs. in-person lectures _2), the logit transformation of preferring virtual learning

Table 3. Characteristics of participants.

Gender	Count	Percent	Study Level	Count	Percent
Female	281	57.58	First Year	312	64.33
Male	207	42.42	Second Year	115	23.71
N =	488		Third year	58	11.96
			N =	485	
			Missing =	3	

Table 4. Analysis of variance.

Source	DF	Wald Test	
		Chi-Square	P-Value
Gender	1	0.00	0.979
Student's Year of Study	2	1.61	0.447
Accessibility of online tools	2	12.02	0.002
Class Engagement in the virtual classes	1	26.65	0.000
GPA Change during COVID-19 outbreak	2	8.37	0.015
C attendance in virtual vs. in-person lectures	2	35.46	0.000
Type of study material	2	7.99	0.018
Time saving for virtual classes	4	2.07	0.722
GPA Change during COVID-19 outbreak	1	4.84	0.028

Table 5. Analysis of variance.

Term	Coef	SE Coef	P-Value
Constant	-3.568	0.451	0.000
Accessibility of online tools			
2	0.598	0.274	0.029
3	-1.928	0.687	0.005
Class Engagement in the virtual classes			
2	1.401	0.264	0.000
GPA Change during COVID-19 outbreak			
2	0.559	0.367	0.127
3	1.079	0.362	0.003
Class attendance in virtual vs. in-person lectures			
2	2.069	0.353	0.000
3	0.828	0.295	0.005
Anxiety level during COVID-19 outbreak			
2	0.846	0.315	0.007
3	-0.011	0.313	0.973
Time saving for virtual classes			
2	0.793	0.383	0.038

is 0.0800 times less likely for a student who has a difficult time accessing online tools compared to a student who can easily access them.

5.4. Odds ratio for level a relative to level B

Consistent with results from Table 5, the results from Table 6 indicate that a student will have more attention towards virtual learning if she/he has attended more virtual lectures, feels that virtual classes are engaging for the students, his/her GPA is increased during the pandemic, does not feel anxious during the pandemic, and saves time by taking online courses. The ease of online access influences students' preference but not as much as the other mentioned factors.

5.5. Students' behavioral preparedness to a second wave of pandemic

On the other hand, to understand the behavioral intention for the students during this pandemic, we mainly focused on capturing their

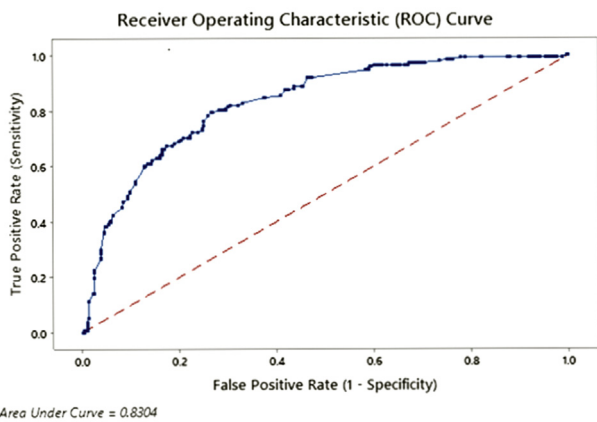


Figure 2. Receiver operating characteristic (ROC) curve.

increases by 2.069. However, when the student access to online tools is hard (Ease of accessing online tools,3), the logit transformation of preferring virtual learning decreases by 1.928. As a summary from Table 5, factors that positively enhance students' preference towards virtual learning is easy access to online tools, class engagement, GPA increase, increased attendance, no anxiety during the pandemic, and time saving. On the other side, the only factor that negatively affected students' preference for virtual learning was the difficulty of accessing to online tools.

To understand the effect of the explanatory variables in the model, we used the odd ratios for the categorical predictors as illustrated in Table 6. Since the predictors in this study are categorical, the event (method of learning) is compared at two different levels for each predictor. When the odds ratio is higher than 1, that indicates the event is more likely to occur when the predictor is at level A. When it is less than 1, this indicates that the event is likely to occur at level A. For example, the odds ratio for student engagement in the virtual classes' variable is 4.0573. This indicates that the odds that a student prefers virtual learning is 4.0573 times higher for a student who feels more engaged in virtual courses. On the other hand, the odds ratio for ease of accessing online tools variable is 0.0800. This indicates that the odds that a student prefers virtual learning

Table 6. Odds ratio for categorical predictors.

Level A	Level B	Odds Ratio	95% CI
Accessibility of online tools			
2	1	1.8179	(1.0627, 3.1101)
3	1	0.1454	(0.0378, 0.5593)
3	2	0.0800	(0.0201, 0.3189)
Class Engagement in the virtual classes			
2	1	4.0573	(2.4174, 6.8095)
GPA Change during COVID-19 outbreak			
2	1	1.7495	(0.8529, 3.5884)
3	1	2.9416	(1.4468, 5.9809)
3	2	1.6814	(0.9623, 2.9379)
Class attendance in virtual vs. in-person lectures			
2	1	7.9158	(3.9666, 15.7969)
3	1	2.2885	(1.2840, 4.0788)
3	2	0.2891	(0.1414, 0.5912)
Anxiety level during COVID-19 outbreak			
2	1	2.3295	(1.2565, 4.3188)
3	1	0.9895	(0.5355, 1.8283)
3	2	0.4248	(0.2209, 0.8167)
Time saving for virtual classes			
2	1	2.2092	(1.0431, 4.6787)

voices on their willingness to wear masks, wash their hands, or both as well as their acceptance to take the vaccine once it is available (Table 7). Most of the students (69.21%) are washing their hands more often and wearing masks as well. 13.43% are washing hands only and 10.33% are just wearing masks. However, 7.02 % of the students did not change their simple health behaviors. This indicates the importance of enacting new laws for opening the universities and applying high fines for violators which might render this 7.02% of student population from violating the rules. On the other hand, more than three fourths (81.57%) of the students are interested in taking the vaccine and around one fifth of them are not interested. This might reveal the importance of implementing virtual health education programs that could be arranged by universities to increase students' awareness in this regard, since universities have crowding, and often host people from different communities and even different countries.

6. Discussion

The World Health Organization classified COVID-19 as a pandemic in early March 2020 [45]. Following that announcement, several governments across the world enacted lockdown measures to mitigate spread of the virus. University and college campuses were temporarily shut down while teaching and learning activities were switched to remote platforms [46]. In accordance, Jordan University of Science and Technology (JUST) switched all coursework to virtual teaching and learning. Virtual learning is not a new concept, in fact, it has been around for about two decades. However, for most of the instructors and students at JUST, it was still a brand-new experience. Most lectures were asynchronous-prerecorded lecture videos that were recorded and uploaded for the students on the e-learning platform. A minor proportion of the instructors delivered live synchronous lectures.

Virtual learning has both positive and negative attributes [47]. It can be used successfully to apply all the teaching skills and experiences as well as develop appropriate knowledge and skills for the students for their learning processes [48]. Of note, teachers at the National Institute of Science and Technology of Toulouse, France admitted that they learned more about virtual/distance learning in two months of COVID-19 crises than in the ten years prior. This is mainly attributed to their obligation and devotion to education during the emergence of the pandemic [49]. However, challenges such as difficulty in ensuring quality of student assessment and limited student engagement remain as problems [50]. Van Doren et al. found that virtual dental learning has been a primary approach to continue the education process during the pandemic but there were some limitations in presenting preclinical and clinical education. The study suggested using videos, virtual cases, and recorded lectures to improve the quality of virtual learning in dentistry [51]. Further, Salter et. al. showed that virtual learning worked efficiently in pharmacy education and increased the knowledge content of the students, however, it was difficult to assess its effect on the skills or professional practice of pharmacists [12]. Notably, clinicians and trainees

were also affected such as surgeon or dental trainers and their education [52, 53, 54, 55].

Many factors affect students' preference towards a particular learning method during a global crisis of epic proportions. In the present study, we examined the effect of factors that affected students' preference for virtual learning. Comparable to the study by Paul et. al [56]. gender was not a significant factor that influence students' preference towards virtual learning. Also, in our study, the study year level of the students and the type of study material were not significant factors on students' preference.

Our results indicated that the students' attendance to virtual classes, class engagement, and anxiety level had an influence on students' preference for virtual learning. Upon shifting to virtual learning, increased burnout, decreased engagement, and the same perception level of class attendance were reported by Dental Medicine students at Harvard School [15]. In addition, a recent study among medical and dental students at Liaquat College reported that 77% of students have negative perceptions towards e-learning and they did not prefer virtual learning over the face-to-face modality during the lock down situation. 84% of these students reported a limited student-instructor interaction [57]. This might be an indicator for academic instructors to include more interactive material to accommodate virtual classes such as discussion forums, uploading study cases and videos, and constructing regular ungraded short quizzes which altogether tend to increase attendance, enhance student engagement with class contents, and decrease stress. Furthermore, students can reduce their stress and anxiety levels by changing their lifestyles such as practicing exercises or planting a garden which might reduce their stress and consequently increase their focus on their studies.

Time saving was also an important factor that affects students' preference for virtual learning. A previous study also reported that virtual learning sessions save students' time and improved their academic performance due to enhanced utility of time [13]. Further, GPA change was a significant factor in determining students' preference for virtual learning. This suggests instructors fulfill a role to ensure that the student assessments are as accurate reflection of their aptitude, that is, the virtual platform does not hinder their performance of over or underestimate their achievement.

In line with other studies, we found that difficulty accessing online tools was a hindrance affecting virtual learning [13, 58]. This suggests that universities should facilitate access to online tools by supporting technologies and offering trainings to increase user competency. Crucially, enhancing accessibility to online tools for all students would address equity and guarantee a fair environment for each student to have access to their classes.

Notably, most respondents indicated that they practiced basic health precautionary measures, yet our study revealed that only 7.02 % of the students did not change their simple health behavior by wearing masks or washing hands. Universities could capitalize on these positive behaviors by emphasizing other global WHO guidelines such as social

Table 7. Students' adaptation to minimal health behavior and their acceptance to the vaccine.

		Count	Percent	Cumulative Count	Cumulative Percent
Health behavior	Did not change simple health behavior	34	7.02	34	7.02
	Hand washing	65	13.43	99	20.45
	Mask wearing	50	10.33	149	30.79
	Both	335	69.21	484	100.00
	N =	484			
	* =	4			
Vaccine Acceptance	Interested	394	81.57	394	81.57
	Not interested	89	18.43	483	100.00
	N =	483			
	* =	5			

distancing to restrict the spread of the disease. Of note, our study also showed that 18.43% of respondents were not interested in taking the vaccine. In the event that a vaccine does become available, administrators may need to be aware of pushback and provide clear guidelines on policing vaccine uptake. Significantly, this also implies that new laws or ordinances may need to be enacted to facilitate safe reopening of universities.

7. Conclusion

Our study possesses a limitation due to reliance on a survey conducted in JUST and thus may not be generalizable to other institutions worldwide. Our study found that accessibility of online tools, class engagement in the virtual classes, GPA change during COVID-19 outbreak, class attendance, and anxiety level during COVID-19 outbreak are significant factors that affect students' preference for virtual learning. In addition, the results showed that 7.02 % of the students did not change simple health behaviors and 18.43% were not interested in taking the vaccine. This implies the importance of enacting new laws for reopening universities while convincing the students to take the vaccine.

Our findings may be beneficial to academic administrators, instructors, and institutions in implementing programmatic tactics to improve effectiveness of virtual learning and increase their readiness for schools reopening. Future studies that analyze more parameters of each variable by asking open-ended questions or interviewing the students can be helpful and better evaluate the effect of the above determined significant parameters and to follow up on our findings. Also, it would be interesting to compare students' preferences for virtual classes versus face-to-face classes in terms of GPA and academic performance in a more detailed manner. In addition, future studies that evaluate the students' performance after the pandemic have to be explored with special attention toward determining the factors that affect students' preference toward online/distance exam evaluations and determining the factors that affect the clinical experience and knowledge of medical and dental students during the COVID-19 outbreak.

Declarations

Author contribution statement

N. Al-Azzam: Conceived and designed the experiments; Performed the experiments; Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data; Wrote the paper.

L. Elsalem: Performed the experiments; Wrote the paper.

F. Gombedza: Conceived and designed the experiments; Wrote the paper.

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Data will be made available on request.

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The authors declare no conflict of interest.

Additional information

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References

- [1] J.E. Morley, B. Vellas, COVID-19 and older adult, *J. Nutr. Health Aging* 24 (4) (2020) 364–365.
- [2] P. Brodin, Why is COVID-19 so mild in children? *Acta Paediatr.* 109 (6) (2020) 1082–1083.
- [3] D. Van, M.L. McLaws, J. Grimmins, C.R. MacIntyre, H. Seale, University Life and Pandemic Influenza: Attitudes and Intended Behaviour of Staff and Students towards Pandemic (H1N1) 2009. *BMC Public Health* 10, 2010, p. 130.
- [4] M.E. Wickman, N.L. Anderson, C.S. Greenberg, The adolescent perception of invincibility and its influence on teen acceptance of health promotion strategies, *J. Pediatr. Nurs.* 23 (6) (2008) 460–468.
- [5] F. Zhou, T. Yu, R. Du, G. Fan, Y. Liu, Z. Liu, et al., Clinical course and risk factors for mortality of adult inpatients with COVID-19 in Wuhan, China: a retrospective cohort study, *Lancet* 395 (10229) (2020) 1054–1062.
- [6] M. Bchetnia, C. Girard, C. Duchaine, C. Laprise, The outbreak of the novel severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2): a review of the current global status, *Journal of infection and public health* (2020).
- [7] L. Elsalem, N. Al-Azzam, A.A. Jum'ah, N. Obeidat, A.M. Sindiani, K.A. Kheirallah, Stress and behavioral changes with remote E-exams during the Covid-19 pandemic: a cross-sectional study among undergraduates of medical sciences, *Annals of Medicine and Surgery* (2020).
- [8] J. Scanlon, What it means to teach consumer culture remotely through a pandemic, *Advertising & Society Quarterly* 21 (2) (2020).
- [9] A. Gacs, S. Goertler, S. Spasova, Planned online language education versus crisis-prompted online language teaching: lessons for the future, *Foreign Lang. Ann.* (2020).
- [10] S.L. Silver, L.T. Nickel, Are online tutorials effective? A comparison of online and classroom library instruction methods, *Res. Strat.* 20 (4) (2005) 389–396.
- [11] C. Hodges, S. Moore, B. Lockee, T. Trust, A. Bond, The difference between emergency remote teaching and online learning, *Educ. Rev.* (2020) 27.
- [12] S.M. Salter, A. Karia, F.M. Sanfilippo, R.M. Clifford, Effectiveness of E-learning in pharmacy education, *Am. J. Pharmaceut. Educ.* 78 (4) (2014) 83.
- [13] R. Khalil, A.E. Mansour, W.A. Fadda, K. Almisnid, M. Aldamegh, A. Al-Nafeeah, et al., The sudden transition to synchronized online learning during the COVID-19 pandemic in Saudi Arabia: a qualitative study exploring medical students' perspectives, *BMC Med. Educ.* 20 (1) (2020) 285.
- [14] T. Gallien, J. Oomen-Early, Personalized versus collective instructor feedback in the online courseroom: does type of feedback affect student satisfaction, academic performance and perceived connectedness with the instructor? *Int. J. e Learn.* 7 (3) (2008) 463–476.
- [15] E. Chen, K. Kaczmarek, H. Ohyama, Student perceptions of distance learning strategies during COVID-19, *J. Dent. Educ.* (2020).
- [16] C.J. Tanis, The seven principles of online learning: feedback from faculty and alumni on its importance for teaching and learning. *Research in Learning Technology*, 2020, p. 28.
- [17] L. Wise, Distance education via the world wide web, 2004.
- [18] N.S. Emeagwali, High school students increasingly learning from a distance, *Techniques: Connecting Education & Careers* 79 (5) (2004) 14.
- [19] T.A. Hjeltnes, B. Hansson, Cost effectiveness and cost efficiency in e-learning. *QUIS-Quality, Interoperability and Standards in e-learning* (2005).
- [20] S. Appana, A review of benefits and limitations of online learning in the context of the student, the instructor and the tenured faculty, *Int. J. e Learn.* 7 (1) (2008) 5–22.
- [21] W.R. Thomas, Web Courses for High School Students: Potential and Issues, 2000.
- [22] Towards web-based adaptive learning communities, in: E. Gaudio, J.G. Boticario (Eds.), *Proceedings of the 11th International Conference on Artificial Intelligence in Education*, 2003 (AIED'2003) Sidney, Australia.
- [23] L. Nguyen, P. Do, Learner model in adaptive learning. *World Academy of Science, Eng. Technol.* 45 (70) (2008) 395–400.
- [24] D. Xu, S.S. Jaggars, The impact of online learning on students' course outcomes: evidence from a large community and technical college system, *Econ. Educ. Rev.* 37 (2013) 46–57.
- [25] L. Liu, Factors influencing students' preference to online learning: development of an initial propensity model, *International Journal of Technology in Teaching & Learning* (2) (2011) 7.
- [26] L.M. Cong, Successful Factors for Adoption of Synchronous Tools in Online Teaching at Scale. *Tertiary Education in a Time of Change*: Springer, 2020, pp. 39–60.
- [27] O. Joshi, B. Chapagain, G. Kharel, N.C. Poudyal, B.D. Murray, S.R. Mehmood, Benefits and challenges of online instruction in agriculture and natural resource education, *Interact. Learn. Environ.* (2020) 1–12.
- [28] J. Kotrlik, C. Higgins, Organizational research: determining appropriate sample size in survey research appropriate sample size in survey research, *Inf. Technol. Learn. Perform. J.* 19 (1) (2001) 43.
- [29] W. Daniel, *The Fisher Exact Test. Biostatistics: a Foundation for Analysis in the Health Sciences*, seventh ed., WW Daniel, ed John Wiley and Sons Inc, New York, 1999, pp. 606–611.
- [30] A.M. Adam, Sample size determination in survey research, *Journal of Scientific Research and Reports* (2020) 90–97.

- [31] R. Hill, What sample size is “enough” in internet survey research, *Interpersonal Computing and Technology: An electronic journal for the 21st century* 6 (3-4) (1998) 1–12.
- [32] R.V. Krejcie, D.W. Morgan, Determining sample size for research activities, *Educ. Psychol. Meas.* 30 (3) (1970) 607–610.
- [33] J.R. Cheema, A review of missing data handling methods in education research, *Rev. Educ. Res.* 84 (4) (2014) 487–508.
- [34] J.L. Schafer, J.W. Graham, Missing data: our view of the state of the art, *Psychol. Methods* 7 (2) (2002) 147.
- [35] J.R. Cheema, Some general guidelines for choosing missing data handling methods in educational research, *J. Mod. Appl. Stat. Methods* 13 (2) (2014) 3.
- [36] Z.W. Jiang, C.J. Li, L. Wang, J.L. Xia, [Prevention and handling of missing data in clinical trials], *Yao xue xue bao = Acta pharmaceutica Sinica* 50 (11) (2015) 1402–1407.
- [37] H. Kang, The prevention and handling of the missing data, *Korean journal of anesthesiology* 64 (5) (2013) 402–406.
- [38] C.K. Enders, Using the expectation maximization algorithm to estimate coefficient alpha for scales with item-level missing data, *Psychol. Methods* 8 (3) (2003) 322–337.
- [39] J.L. Schafer, Multiple imputation: a primer, *Stat. Methods Med. Res.* 8 (1) (1999) 3–15.
- [40] D.A. Bennett, How can I deal with missing data in my study? *Aust. N. Z. J. Publ. Health* 25 (5) (2001) 464–469.
- [41] C.-Y.J. Peng, M. Harwell, S.-M. Liou, L.H. Ehman, Advances in missing data methods and implications for educational research, *Real data analysis* (2006) 3178.
- [42] J.M. Brick, G. Kalton, Handling missing data in survey research, *Stat. Methods Med. Res.* 5 (3) (1996) 215–238.
- [43] E.C. Norton, B.E. Dowd, Log odds and the interpretation of logit models, *Health Serv. Res.* 53 (2) (2018) 859–878.
- [44] H.A. Park, An introduction to logistic regression: from basic concepts to interpretation with particular attention to nursing domain, *Journal of Korean Academy of Nursing* 43 (2) (2013) 154–164.
- [45] D. Pertile, G. Gallo, F. Barra, A. Pasculli, P. Batistotti, M. Sparavigna, et al., The impact of COVID-19 pandemic on surgical residency programmes in Italy: a nationwide analysis on behalf of the Italian Polyspecialistic Young Surgeons Society (SPIGC), *Updates Surg* 72 (2) (2020) 269–280.
- [46] A.K. Arora, R. Srinivasan, Impact of pandemic COVID-19 on the teaching–learning process: a study of higher education teachers. *Prabandhan: Indian Journal of Management* 13 (4) (2020) 43–56.
- [47] D.M. Mupinga, Distance education in high schools: benefits, challenges, and suggestions. *The clearing house: a journal of educational strategies*, *Issues and Ideas* 78 (3) (2005) 105–109.
- [48] K. Lee, J. Lee (Eds.), *Benefits of a Virtual Learning Environment in Enabling Collaborative and Constructivist Learning in a Community of Specialist Nursing Practice*. IEEE International Conference on Advanced Learning Technologies, 2004 Proceedings, IEEE, 2004.
- [49] N. Dietrich, K. Kentheswaran, A. Ahmadi, J. Teychené, Y. Bessière, S. Alfenore, et al., Attempts, successes, and failures of distance learning in the time of COVID-19, *J. Chem. Educ.* (2020).
- [50] F. Koumpouras, S. Helfgott, Stand together and deliver: challenges and opportunities for rheumatology education during the COVID-19 pandemic, *Arthritis & rheumatology* 72 (7) (2020) 1064–1066.
- [51] E.J. Van Doren, J.E. Lee, L.S. Breitman, S. Chutinan, H. Ohyama, Students’ perceptions on dental education in the wake of the COVID-19 pandemic, *J. Dent. Educ.* (2020).
- [52] R. Blanco-Colino, A.S. Soares, S.Z. Kuiper, G. Zaffaroni, F. Pata, G. Pellino, Surgical training during and after COVID-19: a joint trainee and trainers manifesto, *Ann. Surg.* 272 (1) (2020) e24–e26.
- [53] G. Gallo, M. Trompetto, The effects of COVID-19 on academic activities and surgical education in Italy, *J. Invest. Surg.* 33 (7) (2020) 687–689.
- [54] A.A. Jum’ah, L. Elsalem, C. Loch, D. Schwass, P.A. Brunton, Perception of health and educational risks among dental students and educators in the era of COVID-19. *European, J. Dent. Educ.* (2020).
- [55] C. Loch, I.B. Kuan, L. Elsalem, D. Schwass, P.A. Brunton, A. Jum’ah, COVID-19 and dental clinical practice: students and clinical staff perceptions of health risks and educational impact, *J. Dent. Educ.* (2020).
- [56] J. Paul, F. Jefferson, A comparative analysis of student performance in an online vs. Face-to-Face environmental science course from 2009 to 2016, *Front. Comput. Sci.* 1 (2019) 7.
- [57] S. Abbasi, T. Ayoob, A. Malik, S.I. Memon, Perceptions of students regarding E-learning during Covid-19 at a private medical college, *Pakistan Journal of Medical Sciences* (2020) 36 (COVID19-S4).
- [58] A. Al-Zahrani, Toward digital citizenship: examining factors affecting participation and involvement in the internet society among higher education students, *Int. Educ. Stud.* 8 (12) (2015) 203–217.